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NOTICE

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But a very serious consequence that may attend an invasion of *Glycyphagus domesticus* is the effect it has on nervous or morbid temperaments. Obviously the occurrence of the mite in such uncontrollable numbers is distressing, but too frequently the effects go beyond anything that one would anticipate.

There is no doubt that it is a practical problem that requires careful attention. One would like to make further observations on the 'cyst-like' stage, particularly to see whether Fräulein Schulze's contention can be verified, that in *Aleurobius farinae*, another Tyroglyphid mite, there are two distinct types of hypopus, one being adapted for securing distribution and the other for surviving adverse circumstances.

It is possible that in *Glycyphagus domesticus* also we might find traces of these phenomena. One would like also to know more of the hygroscopic quality of Algerian fibre, and what changes take place in the fibre at a high degree of humidity, that render it so attractive and healthy for mites. Work on this problem, particularly in relation to fumigants, is now being carried out at the Imperial College under Prof. Munro's supervision.

Although this is a mere outline of certain aspects of the subject, it indicates that there is much that will need careful investigation before the situation may be regarded with any degree of satisfaction.

The PRESIDENT, in thanking Dr. Finnegan for her exceedingly interesting communication, wondered whether any remains of soft matter adhering to the vegetable fibres used in the place of horse-hair afforded some food for the mites. He suggested that if this were the case the soaking of the fibres before use with some poisonous substance, like corrosive sublimate, might limit the plague of mites.

Dr. G. P. BIDDER asked Dr. Finnegan if it was possible that direct sunshine efficiently destroyed the mites. At Naples, forty years ago, an imported vegetable fibre known as 'végétale' was used for stuffing, above the springs of a spring mattress, but mattresses were annually pulled to pieces on the roof and remade in the summer sun. Do Dr. Finnegan's investigations possibly indicate that this cleanly habit of Mediterranean housewives should be imitated in regard to English upholstery?

After remarks by Dr. CALMAN, Mr. J. T. CUNNINGHAM, and Mr. T. B. BLOW, Mr. J. RAMSBOTTOM asked whether the moulds mentioned by Dr. Finnegan might not play a part in the nutrition of this interesting mite. The fungi presumably are growing on the fibres and may provide food for the mites either by thus forming products which can be assimilated or they themselves might be eaten.

In reply, Dr. FINNEGAN said that the President and Mr. Ramsbottom had touched on a crucial point in their reference to the food of these mites. She was convinced that the mites only attacked grain, dried vegetable products, or fibre that was already damaged. The invasion of mites in numbers in grain stores was invariably to be associated with an earlier attack of fungi or bacterial action.

Orobanche minor on unusual hosts.

By Miss R. E. Dowling.

THE occurrence of *Orobanche minor* on *Plantago Coronopus* was noted at Slough in 1930 and again on two similar host-plants in 1931. Previously no other specimen of *O. minor* had been seen in the garden on this or any other host.

Simultaneously with the second appearance of *Orobanche minor* on *Plantago Coronopus* a plant of *Pelargonium* growing in a pot was found to be parasitized by *Orobanche*.

This simultaneous occurrence of *O. minor* on two unusual hosts in the same area, together with the proximity of *Trifolium* which is its most usual host, seems to suggest a preference for the *Plantago* over the *Trifolium* as a host, and may perhaps indicate something that can be regarded as a physiological mutant, resulting in forms able to live on other hosts and perhaps even preferring to do so.

Prof. E. J. SALISBURY emphasized the interest of Miss Dowling's observations as suggesting the possibility of biological strains in *Orobanche minor*. He also raised the question whether the members of this genus invariably died after flowering. Many facts still remained to be cleared up with reference to the biology of the Broomrapes. Their distribution offered a number of interesting problems. The genus, as a whole, is southern in character, and it is noteworthy that one species (*O. elatior*) is especially abundant on lynchetts, the cultivation terraces of Mediterranean man. It is possible that this species owes its introduction to these early immigrants, who may well have brought in the Broomrape with their agricultural seeds.

Mr. A. J. WILMOTT cited a further record of *Orobanche minor* on *Pelargonium*, from the Imperial Forestry Institute, Oxford. He hoped that Miss Dowling would provide some evidence whether the different-looking forms of *O. minor* were the same plant altered by growing on different hosts, or were really different strains keeping to one host.

The PRESIDENT expressed his interest in Miss Dowling's observations. It was important, as Beck had stated in his 'Monograph of the Orobanchaceae', that the various host-plants of the different species should be recorded, and that the observations should be made with great accuracy, as sometimes

the roots or stolons of grasses or other plants passed through the tuberous swellings from which the flowerspike of *Orobanche* arose, and thus simulated a parasitic attachment. He hoped Miss Dowling would undertake some experimental work with a view to ascertaining whether *Orobanche minor*, which appeared to be one of the most adaptable of Broomrapes, could become parasitic on the roots of Monocotyledons and of Ferns, as this was considered impossible by Beck von Mannagetta.

In recent articles in the 'North Western Naturalist' by Isaak Hartley, vol. vi. 1932, p. 29, various host-plants of *Lathraea squamaria* had been enumerated, and these included the Bracken, so it might be possible that *Orobanche* could attack the rhizome of this fern. The President referred to the persistence underground of the tuberous swellings of the Broomrapes, and mentioned that during his visit to Sicily last spring he had observed large numbers of white spikes of a species of *Orobanche* in several bare fields, from which leguminous crops had been gathered in the previous autumn. Evidently some portion of the parasite had remained underground during the winter. Either it had stored enough food-material in its tuberous swellings or alternatively it might become saprophytic on the dead tissues of the former host-plant. This had been suggested in the case of *Lathraea* by Mr. Hartley.

The PRESIDENT having expressed the thanks of the meeting, the author replied.

Shore biology in Florida.

By Mr. Geoffrey Tandy. (Lecture.)

MR. TANDY gave an account of the joint work of Mr. J. S. Colman (zoologist) and himself during the three months season at the Marine Laboratory of the Carnegie Institution of Washington, situated at the Dry Tortugas, Florida. The methods evolved during the Great Barrier Reef Expedition were used in the hope of obtaining directly comparable results. Accordingly a biological and topographical survey of a system of reefs was undertaken. From this it may be stated that, according to Spender's definition [Geogr. Journ. lxxvi, 35 (1930)], Long and Bush Keys (with the possible inclusion of Bird Key reef) together form a Class IV reef, *i. e.*, one 'having sand-cay and ramparts; the ramparts vegetated' but no mangrove-swamp. There are between two and three hundred very young *Rhizophoras* at the inner edge of the rampart, but these are insufficient to make it a Class V reef. A notable feature when compared with Australia is the number of 'parallel' or 'representative' species. This causes similar habitats to have a remarkably similar appearance in those widely separated areas.

The succession on orientated concrete cubes was investigated by the weekly examination of a representative from four groups in stations selected to give the widest range of easily available conditions.

Mr. J. RAMSBOTTOM expressed the opinion that the results of the collaboration between a botanist and a zoologist in the work just described emphasized the value of such team work and also the benefit of having similar areas in different parts of the world visited in this way. The collection of sea-weeds brought back by Mr. Tandy was exceedingly valuable, as not only did it contain well-preserved specimens in long series but also included some species which previously were known only as scraps.

Mr. J. T. CUNNINGHAM also spoke.

The PRESIDENT closed the meeting with a vote of thanks to the lecturer.

7 JANUARY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The proceedings of the General Meeting held on Thursday, the 3rd December, 1931, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellow signed the Obligation in the Book of the Charter and Bye-Laws and was admitted:—Marion Evelyn Odell.

Certificates of recommendation of the following candidates for Fellowship were read:—For the first time, in favour of Idris Giles Lewis, Cecil Clement Dowding, Edward Thomas Brown, William Borlase, and Alec William James Haggis.

An experiment upon the polarity of the tuber of *Tamus communis* Linn. By Mr. I. Henry Burkill.

WHEN the seed of *Tamus communis* germinates the cotyledon pushes out the young plant, and immediately upon the opposite side of the stem a swelling appears which develops into a globose body, and then getting a vertical axis grows down into the soil and becomes the perennial tuber. When the seed of such a *Dioscorea* as *D. bulbifera* Linn. germinates the cotyledon functions in exactly the same way; and in exactly the same way a swelling develops into a globose body which acquires a vertical axis and becomes the tuber: only it is annual. Every year a new shoot arises from the upper part of the old tuber and a swelling which appears at its base grows into a new tuber by the side of the old one.

Very many tropical species of the family live in this way,

with a complete change of every organ within the twelve months, the shoot and the roots, all of which are adventitious, dying at the end of the season of growth, and the tuber perishing in the next season's growth. But in temperate regions, as if the cost of such a complete renewal were too high, the storage organs are not scrapped, though the rest of the plant is : for instance, a perennial tuber occurs in *Tamus*, a perennial corm in *Dioscorea* § *Borderea*, a perennial rhizome in *Dioscorea* § *Stenophora*, a great persistent hard-coated tuber in *Dioscorea* § *Testudinaria*, and apparently perennial structures in some of the South American species, which ascend the temperate Andes, but our knowledge of these last is very inadequate.

The tuber of *Tamus* except for its duration is the same thing as the tuber of almost any of the *Dioscoreas* of tropical Asia,—a cauline reservoir for food, formed upon a stem out of a lateral swelling, which obtains a new axis of growth, and a symmetry about it. It may often be demonstrated in *Dioscorea* to circumnutate in the same direction as the above-ground stems. In both forming neither bracts nor buds it maintains over its whole surface the potentiality of fresh growth. That of *Tamus* exercises the potentiality by increasing in girth as well as in length.

With the purpose of understanding it better, I dug in the spring of 1931 a number of small *Tamus* tubers from lane-sides in Devon and brought them into my garden in Surrey, planting them, after performing various mutilations, horizontally instead of vertically, and allowed them a full season's growth. They showed very clearly that the tuber is much more ready to send out a shoot from the head end than from lower down, and much more ready to produce new storage tissue from the lower than from the higher parts :—

(i) if the head was present, the season's new leafy shoot was produced from it :

(ii) if the head had been removed, a new leafy shoot was rather tardily produced from a little but uncertain distance below the cut, nearer to the upper than to the lower end :

(iii) if the tip of the tuber was present, elongation took place from the side of it vertically downwards : and

(iv) if the apex of the tuber had been removed, one or more lateral lobes arose from the lower surface, being, if more than one, in a row, the lowest the most vigorous.

The Γ -shape which a whole tuber assumes under these experimental conditions is striking, and it is very interesting that broken tubers placed horizontally send out lobes nowhere but from the lower surface.

Some years ago an experiment was done with tubers of *Dioscorea alata* Linn. These were cut transversely into sections and planted in rows in the order of their cutting,

from the head to the tip of the tuber. The head threw up a new shoot first and the tip last (see Gard. Bull. Straits Settlements, i, 1915, p. 306), thus indicating a polarity, as in the *Tamus* tubers. In another experiment polarity was demonstrated in bulbils of *Dioscorea bulbifera* (Journ. As. Soc. Bengal, vii, 1911, p. 467).

It has been mentioned that the tuber of *Tamus* grows in girth as well as in length; by this process there is growth over the whole surface. The genus is exceptional among Monocotyledons in having secondary thickening. It is probable, or even more than probable, that were it not for the annual increments of young tissue over the surface produced in this secondary thickening the broken tubers could not regenerate, as the examples before the meetings show; and in this regeneration we see the advantage of the abnormal growth from a new angle.

After Dr. A. B. RENDLE had spoken, the PRESIDENT in thanking Mr. Burkill for his communication commented on the interest of the experiments and suggested that from their mode of origin the tubers seemed to be of an indeterminate character intermediate between roots and shoots. The polarity of such organs is naturally of great interest as compared with the normal organs of plants. He suggested that further experiments should be made in which the tubers should be placed inversely with the apex above and the base below.

Mr. A. H. G. ALSTON suggested that the physiological process involved was similar to that described by Went [Zeitschr. Bot. xxiii, pp. 19-26, 1930] for *Bryophyllum*.

Mr. BURKILL, replying, said that his experiments with *Tamus* would be renewed in the coming season, and that the one suggested by the President of reversing completely the position of the tuber would be tried. He added that he had in hand experiments upon the effect, as regards the formation of new storage-tissue, of arresting the growth of the shoot from sprouting bulbils of *Dioscorea bulbifera* and *D. macroura*.

**Some seeds taken from the nest of the harvesting ant,
Messor barbarus. By Mr. T. A. Dymes.**

SEEDS were taken from a nest at Bordighera, Italy, in March 1925, by Mr. H. St. J. K. Donisthorpe, and sent to me for identification. In addition to seeds the material consisted of an appreciable amount of grit and a few silicules of *Alyssum maritimum*.

The seeds were sorted into twenty-six lots and named provisionally: the fact that the ants had removed such things as elaiosomes, papillæ, and pappus and had in some cases rasped sculptured testas almost smooth, added to the difficulty of identification.

As it was desirable to obtain the evidence of the seeds themselves by raising seedlings and growing them until they reached the stage at which they could be identified, sowings were made in 1925 and 1926 in sterilized soil.

Two lots produced the same species as two others:—*Geranium rotundifolium* and *Alyssum maritimum*.

They had been named vaguely *Geranium* and *Cruciferae*, as the seeds were so worn and nibbled that it was not possible to venture any further.

A list of the species is appended, from which it will be seen that, out of the twenty-six sowings, six did not germinate, so those attributions must remain unproved; two produced seedlings which, so far as their evidence went, supported the attribution; they were *Trifolium rubens* and *Thrincia tuberosa*. The former was a typical *Trifolium* seedling and the other produced leaves and a taproot like those of the *Thrincia*; but in neither did the seedlings survive the winter. The remaining eighteen sowings, including the duplicate *Geranium* and *Alyssum*, produced sixteen species, all of which attained maturity and mostly confirmed the preliminary attribution. The most noticeable exception was a lot sown as a Crucifer; it had suggested either *Thlaspi* or *Lepidium*, but it proved to be the Hottentot fig, *Carpobrotus edulis*. The only other alien to the Italian Riviera was *Calendula stellata*; in this, however, there was no germination, so the attribution, although hardly in doubt, was not proved.

In addition to the free separate seeds in the test-tube there was a large number of little lumps of three to eight seeds stuck together; they were sown also in sterilized soil, but they did not produce anything that was not obtained also from the other sowings; the majority proved to be *Alyssum maritimum*.

Before the material had been sent to me it had been cast upon water to free it from the heavier grit, and it was this operation, and not anything that the ants had done, that was responsible for the coherence. Most of the plants produced were *Alyssum*, *Parietaria*, *Piptatherum*, *Tunica*, or *Carpobrotus*, and on testing the seeds, which had already been on water once, those of *Alyssum* were found to be still sufficiently mucilaginous to stick to one another or to a piece of paper, thus accounting for the formation of the lumps.

When all the seeds that could be seen under a one-inch objective had been picked out a considerable amount of grit was left, containing only a small number of mutilated seeds and some fragments; sown in the same sterilized soil it produced nothing but a few *Alyssum maritimum*.

The test-tube therefore contained the seeds of twenty-four species, and the list shows that, assuming the correctness of the eight unproved attributions, they belonged to sixteen

families. It shows also that the number of the seeds of the same species varied from one to several hundreds, and it is clear that this ant thinks highly of the three natives *Alyssum*, *Parietaria*, and *Piptatherum*, and of the alien *Carpobrotus*.

The only remaining item is the silicules of *Alyssum* and their fragmenta. Although they were not very numerous, some were small and young, others nearly ripe, while several had dehisced, supplying loose valves and repla, either with or without the septum; here and there a seed was still attached to its replum.

In conclusion, I thank Mrs. Clement Reid for her assistance in the preliminary naming, and also Mr. A. J. Wilmott, who helped me to identify some of the plants raised, as well as, amongst others, the President, at whose suggestion the seeds were sent to me for identification.

REFERENCES

- MOGGRIDGE, J. T. 'Harvesting Ants and Trap-door Spiders.' London, 1873, and Supplement, 1874.
 SERNANDER, R. 'Entwurf einer Monographie der Europäischen Myrmekochoren.' Kongl. Svenska Vetenskapsakademiens Handlingar, Band 41, No. 7. Uppsala and Stockholm, 1906.

Number of seeds	List of Seeds Name
1	<i>Glaucium luteum</i> Scop.
∞	* <i>Alyssum maritimum</i> Lamk.
5	† <i>Eruca</i> sp. or <i>Brassica</i> sp.
7	† <i>Helianthemum</i> sp.
56	<i>Tunica Saxifraga</i> Scop.
29	<i>Geranium rotundifolium</i> Linn.
10	<i>Lotus ornithopodioides</i> Linn.
7	† <i>Trifolium arvense</i> Linn.
3	† <i>Trifolium rubens</i> Linn.
15	† <i>Trifolium</i> sp.
5	<i>Foeniculum officinale</i> All.
∞	<i>Carpobrotus edulis</i> (L.) N.E. Br.
80	<i>Inula viscosa</i> Ait.
1	<i>Leontodon autumnale</i> Linn.
8	† <i>Thrincia tuberosa</i> DC.
2	† <i>Calendula stellata</i> W.
24	<i>Echium pustulatum</i> Sibth.
1	<i>Plantago Psyllium</i> Linn.
1	† <i>Chenopodium Bonus-Henricus</i> Linn.
6	<i>Polygonum aviculare</i> Linn.
2	<i>Euphorbia Peplus</i> Linn.
26	<i>Euphorbia segetalis</i> Linn.
∞	<i>Parietaria diffusa</i> M. & K.
∞	<i>Piptatherum multiflorum</i> (Desf.) Beauv.

* Also silicules ripe and unripe.

† These seeds did not germinate.

‡ Seedlings died in infancy.

Mr. H. N. RIDLEY called attention to the abundance of *Alyssum maritimum* seeds conveyed by the ants, and stated that he had seen the plant spread from gardens in spots where the seed might have been conveyed by ants.

The PRESIDENT expressed his special interest in Mr. Dymes's exhibit, as he had suggested to Mr. Donisthorpe that the seeds should be sent to Mr. Dymes for identification and also because he had himself investigated the distribution of the seeds of the gorse and broom by ants. In these two plants the seeds possessed large and conspicuous oil-containing bodies (elaiosomes), and he wished to ask Mr. Dymes whether all the seeds identified by him were contained in the list of seeds mentioned by Sernander as collected by ants. He complimented Mr. Dymes on the completion of a difficult task and expressed his admiration for the systematic and careful way in which the work had been carried out and the results checked by germination of the seeds.

In reply to questions by Mr. H. N. Ridley and the President, Mr. DYMES said (1) that he thought ants were very valuable for the local dispersal of *Alyssum*, and that they were attracted to the seeds by the narrow membranous border, which was often removed, and by mucilage in the testal cells: other attractions in one species or another, in addition to the elaiosome, were papillæ and oil in the testal cells, as well apparently as pappus, which was often removed from the Composite fruit.

(2) That, in the material received by him, the proportion of severely mutilated seeds was very small; later on in the year it would probably be much larger, and would increase until the time came for the ants to clear out their galleries and restock them.

(3) That it was generally believed that *Messor* and other ants kept the granaries dry and ventilated, so that they should not become choked and ruined by germinating seeds and seedlings; that, if the seeds got wet, they were brought out to dry in the sun, and were replaced after any radicles that might have been produced had been bitten off.

(4) That he thought that, apart from the two aliens, the bulk of the genera, if not always the same species, had already been recorded, by Moggridge, Sernander, or other observers as being dispersed by ants, although not always by *Messor barbarus*.

An expedition to Mount Olympus.

By Mr. J. L. Chaworth-Musters.

VERY little has hitherto been known about the mammals of Greece, and the object of this expedition was to make a collection for the British Museum (Nat. Hist.). The speaker was accompanied by Mr. Mark Dineley, who took the

photographs exhibited on the screen. The first locality visited was Larissa, where a plague of the Thessalian vole (*Microtus hartingi*) was investigated and a large series of this animal was obtained.

From Larissa the expedition moved to its main base, the monastery of St. Dionysios, 3000 ft. up on the eastern slopes of Mt. Olympus. Three months (March to May) were spent here, and the monastery proved an excellent collecting station. It was situated in a beautiful valley, the northern slopes of which were covered by a dense forest of *Pinus nigra*, *Juniperus Oxycedrus*, hazel, and oak. The southern slopes were well wooded with beech, *Abies Borisii regis*, and higher up *Pinus Heldreichii*. A large number of interesting mammals were collected, including a mole related to *Talpa caeca*, a water-shrew, *Neomys milleri*, a large series of *Pipistrellus savii*, a specimen of the rare bat *Myotis emarginatus*, and one specimen of the common dormouse, *Muscadinus avellanarius*, hitherto unrecorded from the Balkan Peninsula. Both the mammals and birds observed on Olympus showed a marked northern element as compared with the known fauna of the lowlands of Macedonia. Collections of plants and reptiles were also made.

Mr. A. J. WILMOTT said that a considerable proportion of the 120 species collected were not recorded for Mt. Olympus in Halaesky's Greek Flora, though given for other Greek mountains. One or two gatherings may represent new forms. A point of interest is the number of British species collected (viz., 23), partly dry soil ephemerals and geophytes, but also several woodland species.

Mr. H. W. PARKER (Visitor) remarked that, in contrast with the affinities shown by the mammals and plants, the herpetological fauna appears to be essentially similar to that of central and southern Europe. Only one of the reptiles and amphibians collected is found in the north, but many of them belong to subspecies unknown outside the Balkan Peninsula. Expectations that such a little-known region might harbour undiscovered local races were not realized.

Dr. W. B. TURRILL called attention to the interesting trees of Mt. Olympus. *Abies alba (pectinata)* is the common fir in the northern parts of the Balkan Peninsula, and *A. cephalonica* (with its varieties) the only fir in Greece south of Thessaly. In a rather broad belt between, including parts of the Rodopes and south to Mt. Olympus, a polymorphic population occurs, the individuals of which show various combinations of the characters of *A. alba* and *A. cephalonica*. Dr. Mattfeld of Berlin has named this population *A. Borisii*. Its origin and taxonomic status remain obscure. Dr. Turrill also urged that future collectors in the Olympus area should

make a careful study of *Fagus* and should search for *F. orientalis*. He also commented upon *Ramondia (Jankaea) Heldreichii*, a very distinct member of the Gesneriaceae, limited to Olympus. It is now again in cultivation at Kew and elsewhere.

After Mr. H. W. PUGSLEY and Mr. M. A. C. HINTON had made some remarks, Mr. J. RAMSBOTTOM complimented the lecturer on having made such an interesting collection of flowering plants, and paid a tribute to the fine condition of the specimens, which gave no suggestion of the difficulties under which they had been dried.

21 JANUARY 1932

Professor F. E. WEISS, F.R.S., President,
in the Chair

The Proceedings of the General Meeting held on Thursday, 7 January 1932, having been circulated, were taken as read and confirmed.

A list of names of those who had made gifts to the Library since the previous meeting was read and laid on the table.

The following Fellows signed the Obligation in the Book of the Charter and Bye-Laws and were admitted: Syed Hedayetullah, James Philp, and Eric Lomax Crossley.

Certificates of recommendation of the following candidates for Fellowship were read:—For the second time, in favour of Idris Giles Lewis, Cecil Clement Dowding, Edward Thomas Brown, William Borlase, and Alec William James Haggis.

The following candidates were balloted for and elected Fellows:—Hugh Charles Sampson, C.I.E., B.Sc., John Scott Lennox Gilmour, B.A., and Jessie Leese, B.Sc.

Some abnormal developments in roots. (Exhibit.)

By Professor F. E. Weiss, F.R.S., Pres.L.S.

THE PRESIDENT exhibited some roots of a tree which had grown in soil containing a mass of rubble. The roots had evidently been injured by contact with stones and broken glass, and in response to the wounding had produced proliferations which had almost enclosed some of the objects and held them fast. Roots of a similar kind had been

exhibited in 1909 to the Society by Mr. Carus Wilson (Proc. Linn. Soc. 1909-10, pp. 1-3, pl. 1), who had found them in a gravel-pit in Kent.

In addition to the roots showing inclusion of stones the President drew attention to some in which the roots appeared to be lapped round by flattened excrescences. Here one might suppose that the roots had been injured by some insect or other parasitic organism which had stimulated the roots to produce these curious overgrowths. No traces of such insects, however, had been found, so that the injury must have taken place at an early stage in the development of the root.

Mrs. C. B. S. HODSON asked Professor Weiss if he had any data on changes in nuclear structure in root-tips or actively growing roots near the growing points after subjection to some form of injury. She remembered seeing such changes described as being induced (in Professor Farmer's Laboratory about 1908) by poisoning.

Mr. W. C. WORSDELL stated that by excising the primary root of seedlings of *Phaseolus vulgaris*, in one or two cases *fasciated* lateral roots were produced. Such curious, flattened structures in roots, as in these and the present exhibit, appear to be caused by the influence of specially strong stimuli. The structures shown in the exhibit appear to be more of physiological than morphological interest.

In reply to the questions the PRESIDENT stated that the roots were those of a Sycamore and were too old when he received them to show any root-tips.

Seasonal changes in colour of *Anomalurus jacksoni*. By Captain Guy Dollman.

CAPTAIN DOLLMAN exhibited a series of skins of *Anomalurus jacksoni* from Mount Elgon which appeared to represent a rufous form of that species. He pointed out that similar changes in colour occur in bats and other mammals.

The so-called colour phases in the Indian Rufous Horseshoe-Bat (*Rhinolophus rouxi*) and allied forms were described in detail by Dr. K. Andersen (1). In these bats there are two distinct phases, a black or brown phase and a rufous or orange phase. For a long time these phases were regarded as constituting an example of dimorphism; and occasionally these colour differences were even used as characters for the description of alleged new forms. Andersen's work showed that the differences resulted from changes in the colour of the pigment granules of each hair; in each hair of the new adult coat the pigment was dark brown to begin with, but

very quickly, by means of a process of bleaching or 'oxidation', it became reddened, with the result that the entire coat assumed a bright orange-rufous hue. It is a remarkable fact that the claws also undergo a corresponding change of colour. In *R. rouxi* this change of colour takes place twice yearly—that is to say, immediately after the completion of the autumn and spring moults.

Similar colour changes take place in many other bats. One of the most striking examples is afforded by *Asellia tridens*, from the Sudan, in which the pale grey of the new coat changes to a chestnut-crimson of an intensity rarely met with in mammals. Other instances are seen in species of *Hipposideros*, among Old World leaf-nosed bats, in *Pipistrellus papuanus*, and in species of the genera *Scotophilus*, *Lasiurus*, *Molossus*, *Eumops*, and *Noctilis* among other groups of the Microchiroptera. One dusky species bears the name *Molossus rufus* because it was founded upon an individual in the red phase.

In one group, the diurnal bats of the genus *Lavia*, in which we might have expected to find a change of colour, there is no trace of alteration, these bats being always of the same greenish tint.

Among the Fruit Bats such colour changes are not so noticeable because in the majority of species the coat is sparse. One instance is afforded, however, among the large forms by an Australian species, *Pteropus gouldi*, and others, among the smaller forms, by species of *Cynopterus* and *Rousettus*.

The colour changes noticed in Squirrels and some other mammals, usually attributed to the bleaching effect of light or oxidation of the pigment, are of a somewhat different type. In such cases the pigment gradually fades, and finally, as in the tail of the British Squirrel, completely or almost completely disappears.

The remarkable changes of colour occurring regularly in the British Squirrel were worked out and described by the late Oldfield Thomas (2). In this animal the winter coat is dark greyish brown; during the spring the colour fades to pale yellowish or drab. The dark ear-tufts and tail of the winter coat fade until they are creamy buff or nearly white; but as a rule the body-coat is shed before it can fade as much as do the tail and ear-tufts. The new body-coat makes its first appearance, in the south of England, about 20 April. In six weeks it is fully developed and appears as a short-haired reddish-coloured rather untidy suit. The tail and ear-tufts meanwhile continue to bleach and the latter usually fall out by the middle of July, so that squirrels in full summer dress usually have no ear-tufts. The tail commences to bleach at the tip, and the bleaching process

spreads upwards to the base. The new tail appears as a median black line, first commencing to show in the basal portion and spreading downwards to the tip. The summer coat usually persists until the end of October, when it is shed and replaced by the winter coat, in which the hairs are about twice the length they are in the summer. The winter hairs are distinctly annulated with brown and dull white; but the brown annulations start to bleach almost immediately after the hair is grown. The summer hairs show no such annulations.

Somewhat similar changes may be observed in certain African Squirrels. In *Heliosciurus mutabilis* we have a striking example. The new coat is speckled grey, occasionally with a black wash down the back. The tint gradually changes to rufous buff as the dark rings of the hairs bleach to rufous and orange. When the new coat appears its grey tint stands out in vivid contrast against the rusty colour of the old coat, and some of the specimens appear very patchy in consequence. Fading appears to take place twice a year, and is probably due to the action of light. The dark pigment in diurnal mammals, with one or two striking exceptions, tends to fade to rusty buff, and this is especially true of annulated hairs. The exceptions are such animals as are entirely black or black and white, like the *Colobus* monkeys. The black pigment of these monkeys never fades, either during life or after death. One can expose them to the strongest sunlight in a museum without any deleterious effect. Some black or black and white animals, such as skunks and bears, however, always fade to a certain extent.

All the colour changes just referred to, embodying the fading of a dark pigment to a rusty tint, might possibly be due to the action of light. The case must, however, be different with such nocturnal animals as Bats, which would at no time of their existence be subjected to such action. It has been suggested that the change is brought about by the oxidation of the pigment, but what the chemical process is and what it is caused by is not at all clear. Mr. Hinton assisted Dr. Andersen in his researches on this subject, but I think they came to no definite conclusion.

Recently my attention has been drawn to a somewhat similar change of colour in an entirely different group of nocturnal mammals. The Museum has received from Mr. Foster, of the Game Department of Uganda, four specimens of an *Anomalurus* among a large collection of mammals from Mt. Elgon. These were at first thought to represent a new species, being strikingly different in colour from any other member of the family. On comparison, however, it became evident that they were referable to de Winton's *A. jacksoni* described from Entebbe.

Three of Mr. Foster's specimens are very much redder than the type and majority of the specimens of *A. jacksoni* in the Museum. Examination of the fourth specimen shows that the black colour of the hairs, so characteristic a feature of *A. jacksoni*, has, in the other three, changed to a rufous tint. This is very evident in the dark patches of hair above the ears, on the upper surface of the membrane, and on the tail. The change in colour in these specimens apparently commences on the head, around the edges of the membrane, and on the tail. The greyish tint of the head and body, so typical of *A. jacksoni*, is in these three specimens distinctly tinged with rufous, approaching the same rusty tint as is seen in the tail and dark ear-patches. The fourth specimen approaches more nearly the typical coloration, the ear-patches and hair on the membrane being blackish in tint.

While working at these Mt. Elgon specimens I have had before me three rufous-coloured Scaly-tails described from the Gaboon by Dr. J. E. Gray under the name *A. fulgens*. These appear to repeat what takes place in the Chiroptera, the red coloration being almost exactly the same as that of the Horseshoe-Bats and other species in the old coat. There is found in the Gaboon and other parts of West Africa a well-known species, *A. beecrofti*. This is sometimes conspicuous for the orange colour of the underparts, and it always presents a small white spot on the crown of the head; all the specimens I have examined possess this spot. It is interesting to find that all three specimens of *A. fulgens* present this latter peculiarity too; and this, combined with the curious red coloration of the pelage, renders the position of this species very precarious.

REFERENCES

- (1) ANDERSEN K. 'On the so-called colour phases of the Rufous Horseshoe-Bat of India (*Rhinolophus rouxi* Temm.).' *J. Bombay Nat. Hist. Soc.* xxv, 1917, p. 260.
- (2) THOMAS, O. 'The seasonal changes in the Common Squirrel.' *Zoologist*, 1896, p. 401.

Major STANLEY FLOWER expressed appreciation of Captain Dollman's paper and the well chosen series of specimens illustrating it, and drew attention to some of the wider issues raised, especially of the probable value to the geneticist and physiologist of such work, which was an example of the broad views on systematic zoology now, happily, held at the British Museum.

Dr. G. S. CARTER asked whether the seasonal variations which are known to occur in the endocrine organs had been

considered in relation to the facts of colour change at moulting etc. described by Capt. Dollman, and particularly whether this had been done in view of the known effects of variations in the amount of thyroid secretion present in the body on the pigmentation of birds.

Professor E. W. MACBRIDE said that the Frog had been mentioned as an animal that exhibited a seasonal change in colour; but experiments conducted in his laboratory, the results of which were exhibited at a Linnean soirée some years ago, showed that the colour of the Frog was regulated by the colour of its environment. If a frog be placed in an accumulator jar, the inside of which is blackened and which contains a little water to ensure a damp atmosphere, in about half an hour it will assume a very dark brown colour. If it now be removed and placed on a white tile its colour will change to a light straw-yellow. If, however, before being placed on the white tile the frog be blinded by having its optic nerves cut it will remain as dark as before.

Dr. W. T. CALMAN pointed out that the reddening of the individual hairs in the cases described by Captain Dollman differed from some other examples of colour change in animals, which had been quoted in the course of the discussion, in that it appeared to be due to a change in the pigment in the dead cells of the hair, and not to movements of pigment occurring within the living cells.

Mr. M. A. C. HINTON said that in assisting Dr. Andersen long ago he had merely made a very careful microscopic study of the pigment granules in the hairs of various bats, and that the appearances noted there appeared to be consistent with the theory of progressive oxidation of the granules which had been advanced by various biochemical workers. Bleaching by light in the case of these bats was, of course, out of the question.

[Addition by Mr. Hinton, May 1932 :—The work referred to, with references, is fully described in Barrett-Hamilton and Hinton, 'History of British Mammals', vol. ii, p. 643, 1916. There it is stated :—"Colour is now regarded by many . . . as resulting from the oxidation of a chromogen by the action of a ferment; the tint produced depending partly upon the nature of the chromogen and partly upon the degree to which it is oxidized. The results of our work . . . lead us to think that the transition from black pigment through brown to yellow is a gradual one, and that it may well be the result of progressive oxidation. The gaseous contents of the medullary chambers perhaps play a part in this process, and the dark hue of the cortical pigment of the hair-tips may be due to the fact that the medullary space dies out before reaching the hair-tip."]

